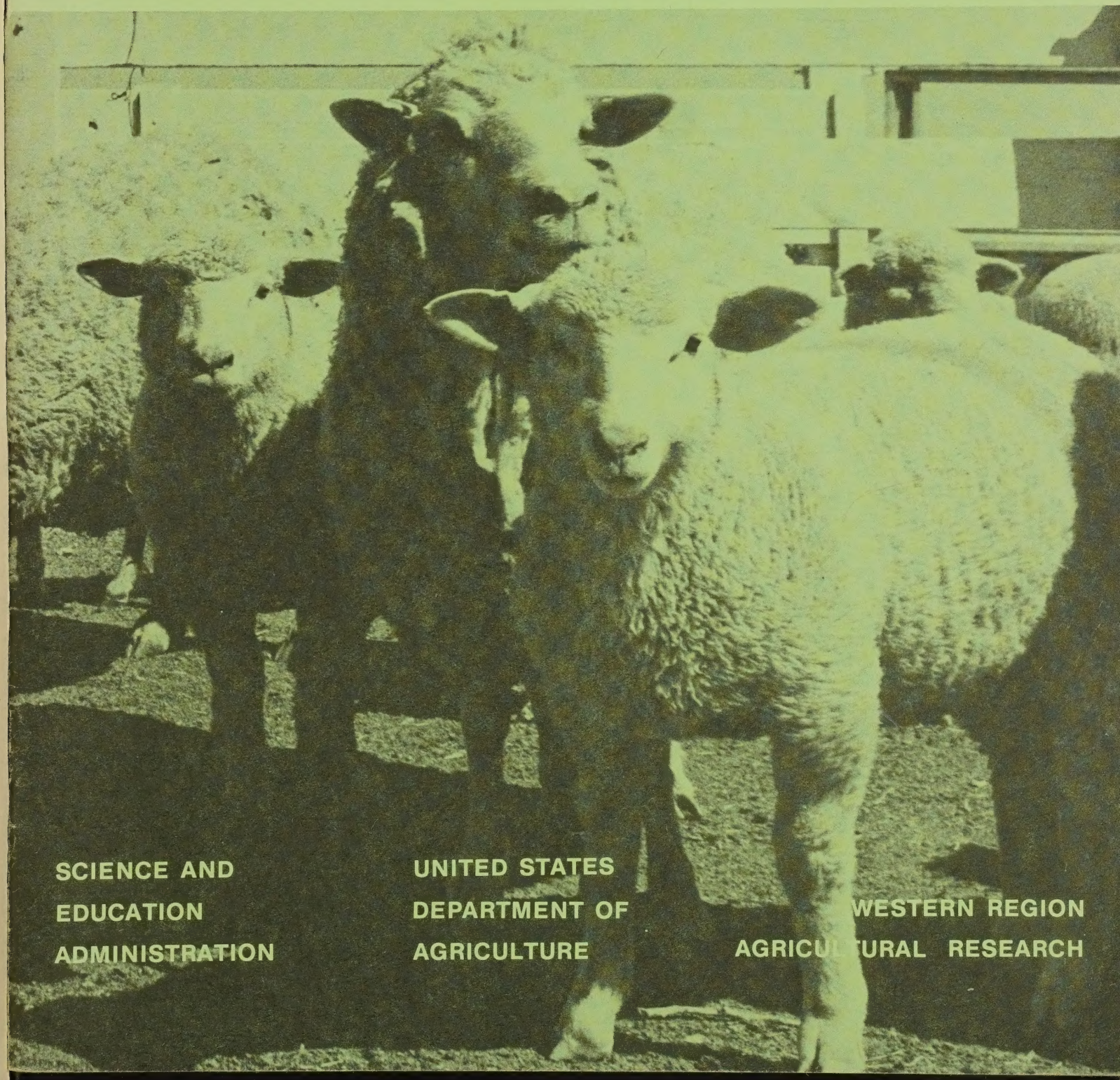
Sheep Production Research At the U.S. Sheep Experiment Station Dubois, Idaho



SCIENCE AND EDUCATION ADMINISTRATION

UNITED STATES DEPARTMENT OF AGRICULTURE

WESTERN REGION AGRICULTURAL RESEARCH

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SHEEP PRODUCTION RESEARCH AT THE U.S. SHEEP EXPERIMENT STATION DUBOIS, IDAHO

INTRODUCTION

The U.S. Sheep Experiment Station was established in 1916 by the U.S. Department of Agriculture (USDA) to conduct range sheep investigations. The primary mission of the research is to find ways to increase production and quality of lamb meat and wool.

The Station is administered by the Science and Education Administration (SEA) Agricultural Research, and is located 6 miles north of Dubois, Idaho, on Interstate Highway 15.

The research programs are conducted in cooperation with the Idaho Agricultural Experiment Station. The Sheep Experiment Station also cooperates with several other Western States.

Approximately 6,000 Rambouillet, Targhee, Columbia, Polypay, and Finn Crossbred sheep are involved in the research program. They graze on 48,000 acres of native range plus 23,000 acres of Targhee National Forest range. The winter feedlot is located west of Mud Lake, Idaho, on State Highway 28.

This brochure is designed to give livestock producers a brief overview of the present research program at the U.S. Sheep Experiment Station.

BREEDING RESEARCH

The breeding research program at the Station is designed to improve the genetic quality of sheep and thereby make them more efficient producers of lamb and wool. Breeding programs are used which bring about genetic changes in biological characteristics that are closely related to important economic traits. Several methods of improvement are being investigated.

IMPROVING SHEEP BY SELECTION

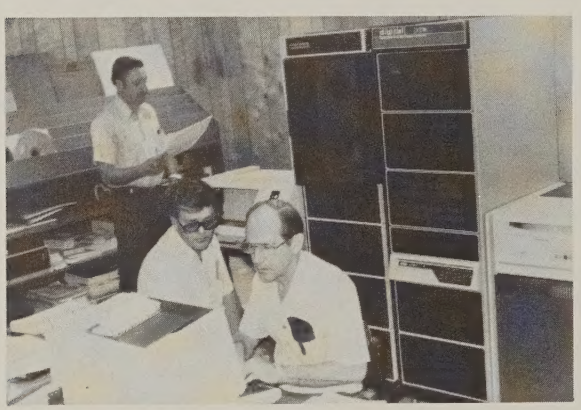
Selection is an important method of achieving genetic change. An important incentive to improving sheep by selection is that the additive genetic gains from selection tend to be permanent. Hence, aside from selection to eliminate problems due to accidents, disease, or age, continued selection pressure is unnecessary except to achieve additional genetic gains or to offset undesirable effects of natural selection. In contrast, costs of many nongenetic methods of improving production, such as improvements in management practices, must be continued indefinitely if the resulting production improvement is to be sustained. The main disadvantage of selection is that annual genetic gains are small, particularly if the selected trait is affected much more by environmental changes than by genetic changes, i.e., if the trait is lowly heritable.

Importance of Records

A prerequisite to efficient genetic improvement is accurate records on each animal for each trait to be improved. In addition, records must be kept for other economically important traits, especially traits related to the animal's fitness, to keep aware of any undesirable changes that may result from selection for emphasized traits. Since records must be associated with individual animals, we use eartags containing identification unique to each animal.

Newborn lamb is eartagged, weighed, and inspected. Eartag number, sex, birth weight and date, type of birth, jaw score, dam's milk, and any defects are marked on data processing cards, which can be quickly and easily processed by a mark sensing machine.

Hence, an important function in the research here is maintaining accurate birth, weaning, yearling, mating, and reproductive records on all Station sheep, and determining the usefulness of any other observable traits as indicators of breeding or economic merit. Included are observations on birth dates and weights, physical defects, milking potential, type of birth (single, twin, triplet, etc.), growth rates before and after weaning, weaning weights and ages, weaning and yearling fleece and body weights and characteristics, semen characteristics of rams, numbers of lambs born, udder characteristics of mature ewes, and other routine annual observations for continued physical soundness of all mature animals.



Modern data processing equipment is needed for processing and analyzing the large amount of data that are collected each year.

Environmental Factors and Accuracy of Selection

A basic problem in achieving genetic changes is that of distinguishing between genetically superior animals and those superior only because of favorable environment. The superiority of the latter animals is not transmitted to their offspring and therefore is not a permanent characteristic of the flock.

To reduce errors in choosing genetically superior animals for breeding, we must account for the environmental effects on each animal. Our research has shown, for example, that lambs reared as twins are from 14 to 20 pounds lighter at weaning than those reared as singles and that twins reared as singles are intermediate in weight between twins and singles. Further, older lambs are heavier than younger lambs at weaning by about 0.5 pound for each day they are older, lambs having 2-year-old dams generally are 3 to 5 pounds lighter than those having 4- to 6-year-old dams, and lambs grazed in particular bands may be 2 to 6 pounds lighter than those of other bands. We have found that environmental factors have proportionately smaller effects on face cover, staple length, fleece weight, horn score, neckfolds, and yearling body weight than they have on body type and condition, type of birth of the lamb, rate of gain over short periods, birth weight, and weaning weight. Therefore, one must exercise increased care in accounting for environmental effects when selecting for the latter traits if selection is to be effective.

When important environmental effects are of short duration, such as some affecting body weight and rate of gain, accuracy of selection often can be dramatically improved by observing the involved traits for longer periods. The extended time gives short-term effects more opportunity to dissipate. For example, we have found that the heritability of body weight increases steadily from weaning to yearling age and that heritability of rate of gain for a 90-day period often is double that for a 42-day period. We also have found that the average environment under which selection is made also is important. For example, progess when selecting for postweaning rate of gain on a dry, sagebrush-grass-type fall range where gains are low is expected to be less than half that obtained when animals are gaining at least one-quarter pound per day in a feedlot on high-quality alfalfa pellets. In this instance, the genetic differences among animals are more accurately observed in the better environment.

Current Selection Objectives

Clearly, the most important way to improve production is to increase reproductive rate, since such improvement multiplies rather than just adds to the current production. In addition, it multiplies any improvement obtained by other means. Hence, much of the current research effort of the Station is directed toward improving net reproductive rate. We have found that such improvement is not likely to be achieved quickly by simply selecting for number of lambs born or by selecting twins. However, there seems to be considerable promise for more rapid improvement if we combine selection for early puberty (that is, ability to breed at 7 months of age) with selection on reproductive performance of the dam, initially, and augment this later with selection on the individual's own lamb production, including pounds of lambs weaned. Lambing twice yearly also can increase progress by reducing the generation interval and increasing the annual reproductive rate. The prebreeding environment should be good enough, particularly for lambs, to permit full expression of genetic potential and thus aid in improving accuracy and maximizing the intensity of selection. We also are trying to improve growth rate, which is probably the most important economic trait

Lambs in individual pens with individual metal self-feeders are being tested for efficiency of postweaning gains.

after reproductive rate, by selecting for weaning weight, postweaning rate and efficiency of gain, and mature (15 to 17 months) weight. We have clearly observed that good feed conversion ratios are not enough; animals also must be gaining rapidly (thus reducing total maintenance costs) on reasonable feed intake. We can increase progress in selecting for efficient (profitable) postweaning gains by about 43 percent by considering body weight off test and feed consumed in addition to rate of gain. While improving these important traits, we also must carefully note any undesirable correlated effects on other traits such as wool production, wool quality, and disease resistance.

IMPROVING SHEEP BY CROSSBREEDING

Often, the fastest method for improving sheep is by crossing breeds each of which possesses superior characteristics needed by the other, since the improvement can be attained in one generation. The disadvantages are that each breed's undesirable characters also are introduced into the crosses and that often there is a subsequent decline in merit (recombination loss) if the crossbreeds are propagated by mating among themselves. If the decline is substantial, the first cross may have to be repeated continually to preserve the initial gains. In this case, even though the crossbreds are superior, some purebreds must be maintained to produce the crossbreds.

High-quality, 12-week-old, 1/2 Suffolk lambs with their yearling 1/4 and 1/2 Finnsheep dams just returned from spring range grazing.

To investigate the possibilities of rapidly increasing reproductive rate by crossbreeding, the Station has introduced Finnsheep into the breeding program and may later introduce other breeds. Finnsheep typically produce two to four lambs per pregancy in their native Finland and are outstanding among the world's sheep breeds for prolificacy. However, they are smaller and have poorer wool production than our western range breeds. We are finding that female crosses of native Rambouillets, Targhees, and Columbias, containing 1/4 to 1/2 Finnsheep breeding, have net reproductive rates and pounds of lamb weaned that are from 125 to 400% higher at yearling age and from 20 to 70% higher at mature ages than our native purebreds when all are bred to Suffolk rams. As noted, the superiority of the crossbreds declines sharply from the first to the second year, but continues thereafter at a lower but consistently superior level (table 1). Current comparative production among 3, 4, 5, and 6-year-olds provides no evidence of any decline in lamb production through 6 years of of age for either 1/4 or 1/2 Finncrosses. Six-year-old 1/4 and 1/2 Finncrosses continue to be superior to Rambouillet, Targhee, and Columbia purebreds by about 25 to 40%, respectively, for weight of lamb weaned per ewe bred. The wool production of the crossbreds is only about three-fourths that of the purebreds, although crossbred wool does have satisfactory processing characteristics. We are also studying the carcasses of the one-half Suffolk offspring from Finncross ewes. Evidence indicates that they are acceptable in composition, quality and yield.

We also want to see if initial lamb production gains achieved by 1/4 and 1/2 Finncross ewes can be maintained or perhaps increased by intermating crossbreds and then selecting intensively for high production. Success of such an inter se breeding system could reduce the need for repeating initial breed crosses to obtain replacement ewes. Inter se mating groups of 1/4 and 1/2 Finncrosses have been established for crosses of each of the three range breeds, Rambouillets, Targhees, and Columbias. A first cycle of selection on lamb production has been completed in the yearling ewes of each group.

POLYPAY SHEEP FOR MORE EFFICIENT LAMB PRODUCTION

One of the greatest needs of the sheep industry is for a breed that not only has good growth rate and carcass quality but is also highly prolific. In an effort to develop such a breed in the shortest possible time, a number of breeds and crosses were tested for performance using the following criteria:

(1) Produce a lamb crop at 1 year of age
(2) High lifetime prolificacy
(3) Lamb twice a year
(4) Good growth rate
(5) Good carcass quality

The Polypay is a composite breed being developed at the Station from initial crosses of Targhee x Dorset and Rambouillet x Finnsheep breeds to obtain a more efficient lamb-production breed excelling in the five criteria mentioned above. Rambouillet and Targhee breeding has been included to retain hardiness, herding, instinct, growth rate and size, and a long breeding season. Dorset breeding contributes to carcass quality, milking ability, and long breeding season. Finnsheep breeding promotes early puberty, early postpartum fertility, and high lambing rate.

Once-A-Year Lambing

Breed comparisons among six breeds and bred crosses (table 1) clearly indicate that the Polypay is performing outstandingly in conventional once-a-year lambing under herded range conditions. Yearly environmental variations accounted for a slight reduction in the lamb production of all breeds and crosses in 1979. Still, in this comparison, mature Polypay ewes dropped a 188% lamb crop from ewes lambing and weaned a 150% lamb crop from ewes exposed for breeding in the fall. During previous years, lamb crop dropped has been as high as 207% from ewes lambing and a 164% lamb crop weaned from ewes exposed for breeding. This kind of production can greatly improve the efficiency and profitability of a sheep enterprise. The Polypay breed also has good growth rate and mutton conformation (see photograph).

Polypay ewe with twin lambs. (see cover)

Twice-A-Year Lambing

A breed that can lamb twice-a-year without any hormone treatment probably can be developed within a reasonable time by careful selection concurrent with lambing in January and February and breeding in February and March and lambing again in July and August and breeding in August and September (see table 2).

This method will require a breed with a relatively short gestation and a short postpartum interval (interval from lambing to conception) as well as a long breeding season. The Polypay breed appears to be well endowed with each of these characteristics and thus is a logical breed to use in selection and management studies to achieve twice-a-year lambing.

Two Polypay lines have now been established and are being selected for twice-a-year lambing without hormone therapy. The effects of early weaning of lambs and improved ewe diets on prompt conception of ewes following lambing are also being investigated.

TABLE 1. Comparative lamb production of various breeds and crosses under herded range conditions at the U.S. Sheep Experiment Station[1]

Age at lambing and breed[2]	Lambs born to ewes lambing	Lambs weaned of ewes bred
	%	%
Avg. of all matures[3]		
Rambouillet	159	122
Targhee	152	107
Columbia	152	97
Polypay	188	150
1/4 F x 3/4 WF	183	136
1/2 F x 1/2 WF	231	162
12-month-olds		
Rambouillet	106	18
Targhee	102	13
Columbia	104	10
Polypay	135	90
1/4 F x 3/4 WF	121	43
1/2 F x 1/2 WF	146	99

[1]Lamb production records for 1979 are shown for average of all matures and for 6-year-olds but records for 1977 are shown for 12-month-olds (the last year lambing records of 12-month-olds were available for Finn-cross ewes).

[2]F = Finnsheep, WF = Rambouillet, Targhee, and Columbia combined.

[3]Average for ages 2 through 6 years.

TABLE 2. Effect of time of year on estrus and ovulation in Rambouillet ewes at Dubois

Month	Ewes in estrus	Ewes ovulating
	%	%
January	100	100
February	100	100
March	89	94
April	26	32
May	2	2
June	7	7
July	12	41
August	6	6
September	100	100
October	100	94
November	100	100
December	100	100

LAMB CARCASS INVESTIGATIONS

Inasmuch as the carcass is the most important product of the sheep enterprise, we must determine what is happening to the carcass as a result of whatever genetic improvement techniques are used. Hence, we slaughter random samples of lambs periodically and carefully observe carcass characteristics. Further, because it is most difficult at present to select directly for improvement in carcass traits, we need to know how the carcass is affected by genetic changes in live animal traits.

We already have verified that live weight at slaughter is very nearly as useful as the whole carcass weight in predicting the weight of preferred cuts and weight of lean in the leg and loin. We have also learned that percentage components of the carcass are much more difficult to predict accurately than weight components and are much less responsive to selection. Also, linear measurements of either live animal or carcass components are much less useful in predicting weight of preferred cuts and lean than is live weight. We have further determined that we are likely to achieve several times greater genetic progress in improving carcass traits by selecting among animals in whose slaughter weights have been permitted to reflect differences in rate of growth than among animals whose traits have been observed at a uniform slaughter weight. We have also observed that slaughter weights of Rambouillet, Targhee, and Columbia ewe lambs can be increased to 130 pounds and ram lambs to 145 pounds without seriously increasing the fat percentage or decreasing the percent lean or preferred cuts (see table 3). Carcass grade in both instances continues to improve, and the percent bone steadily decreases up to these weights. The result is importantly reduced fixed costs per pound of meat and increased lean meat production per mating made. Furthermore, consumer acceptance studies recently completed in cooperation with Utah State University have indicated that there is not the slightest discrimination by the consumer against cuts from these heavier carcasses.

TABLE 3. Some carcass comparisons of ewe lambs slaughtered at 110 and 130 pounds and of ram lambs slaughtered at 110 and 145 pounds

Item[a]	Sex and slaughter weight			
	Ewe		Ram	
	110	130	110	145
% Lean	56.0	56.2	57.3	57.6
% Fat	26.7	27.2	22.9	25.7
% Bone	15.7	15.6	17.6	15.5
Fat/Lean	.48	.49	.40	.45
Lean/Bone	3.60	3.71	3.30	3.76
Tenderness	4.85	5.75	4.79	4.97
% Prime cuts	76.28	78.93	77.59	76.85
USDA Grade	10.82	11.00	9.78	11.03

[a]Percentages and ratios are based upon physically separated lean, fat, and bone tissues of the leg and loin (wholesale cuts). Tenderness values were determined with a Warner-Bratzler shear and are pounds of force required to shear a cooked core sample of Longissimus (loin eye) muscle (values up to 8 pounds are very acceptable). USDA carcass grades are coded as follows: prime=14, choice=11, good=8, fair=5, and poor=2.

PHYSIOLOGY OF REPRODUCTION

FLUSING AND BREEDING TIME

Flusing in the fall at the Station has resulted in little if any increase in percent lamb production over a 3-year period but gives some response in midwinter (Sept., -3%; Nov., +9%; Jan., +26%). September breeding has resulted in more live lambs born than breeding in November or January (1.74, 1.63, 1.36 live lambs per ewe, respectively).

ACCELERATED LAMBING

Accelerated lambing offers a real opportunity for sheep producers to improve reproductive efficiency and net return by reducing overhead costs in relation to production.

Of the several accelerated systems which have been explored an 8-month-interval lambing appeared at one time to have the most successful application. However, this system has been heavily dependent on hormone therapy and hormones no longer appear to be commercially available. Researchers at Purdue University have demonstrated that this system is possible without hormone treatment. Their work shows that success is dependent upon: (1) selection of an adapted breed or strain, (2) intensive genetic selection for response, (3) careful selection of best breeding and lambing times specific to the geographic location of the operation and (4) good nutrition and management.

Twice-a-year lambing may be the most efficient and easily managed accelerated system today. It is the only accelerated system adaptable to the range sheep industry and will also fit in better with other farming operations of many farm flock owners. The natural occurrence of relatively consistent twice-a-year lambing in certain exotic breeds and the occasional occurrence in domestic breeds attests to its feasibility. We have identified the Polypay as the most adaptive breed at the Dubois environment of the breeds which we have tested (Rambouillet, Targhee, Columbia, Dorset x Targhee and Finnsheep x Rambouillet). Successful performance is also dependent upon breeding early in the breeding season (mid-August) at Dubois so that ewes can be lambed out and re-bred before the end of the breeding season (mid-February to mid-April).

Polypay ewes with fall lambs at side breeding for a spring lamb crop.

We have found that introducing sterile rams to the ewes in early August results in an earlier more uniform lambing than no early ram exposure. We have also found that early weaning is essential for fertility in the early postpartum ewe in the late winter and spring. Results in a recent trial indicated that weaning at 31 days of age may result in higher fertility (40% lambing) than weaning at 41 days of age (30.2% lambing). We are confident that selection will be effective in improving fertility in the early post partum ewe in February and March.

Polypay ewes and lambs.

A rapid, efficient laparotomy technique developed at Dubois for observing ovulation rate through a speculum.

When we supplemented our ewe lambs on dry fall range with an average of 1.75 pounds of alfalfa pellets 94% of the Polypay, 16% of the straight Rambouillet and 57% of the Targhee ewe lambs lambed at 12 to 13 months of age. When not supplemented in the fall, only 12% came in heat their first winter. The Finnsheep crossbred ewes will breed at a younger age than the other breeds. About 80% of our ewes that bear live lambs at one year of age wean lambs under range conditions. Most lambs were 90 to 115 pounds at breeding.

BREEDING EWE LAMBS

Breeding ewe lambs offers a real potential for increasing lamb production and net profit and is also a part of our plan to develop an intensive lamb production system. Besides the cost to maintain ewe lambs their first winter, if one invests an additional $4 or $5 in supplemental feed or good pasture or crop residues to continue rapid growth following weaning, and during breeding (1/3 to 4/10 lb per day), a high percentage will breed and produce lambs at 12 to 14 months of age even in range flocks. Beet tops, aftermath in grain fields, or alfalfa fields have been used successfully. Good quality range can be used with adequate supplementation with range cubes or concentrates. For ewe lambs in confinement feed alfalfa pellets at a rate of 4.0 to 4.5 pounds per day. High quality hay with 1/2 to 1 pound of grain per lamb per day can produce satisfactory gains.

PREGNANCY TESTING CAN PAY

Sheep producers can get a head start on profits by culling lambs saved for breeding flock replacements while they are young enough to sell as fat lambs. Early culling involved breeding replacements at 7 to 9 months of age, pregnancy testing starting at 65 days after breeding, and selling the nonpregnant ewes as fat lambs.

This system offers three sources of increased income. First, the culls can be sold as fat lambs at a relatively high price per pound compared with a relatively low price per pound for mature ewes. Second, replacements that lamb the first time as yearlings have a higher lifetime production of lambs than those bred to drop first lambs as 2-year-

TABLE 4. Lamb production of Targhee range ewes bred and selected on pregnancy as compared to ewes lambing for the first time as 2-year-olds

Management practice	Age of ewe	Ewes lambing	Lambs born[1]	Lambs weaned[1]	Total lamb weaned
	Yrs.	%[2]	%	%	Lbs.
Lambed 1st as yearlings	1	100	111	83	56
	2	98	143	115	84
	3 or over	97	158	134	107
Lambed 1st as 2-year-olds	1	0	0	0	0
	2	88	102	82	58
	3 or over	89	141	115	87

[1] Percent lambs born or weaned of ewes bred.
[2] Only those ewe lambs diagnosed pregnant were saved.

olds (table 4). Third, feed and labor costs can be reduced since infertile females are discovered as lambs rather than as 2- or 3-year-olds.

The system works as follows. If you need 40 replacement ewe lambs and can reasonably expect a conception rate of 67 percent or higher, you simply breed 60 lambs, pregnancy test (technique described below), and send the 20 nonpregnant lambs to market. Information on how to successfully breed ewe lambs may be obtained from J.J. Dahmen, Department of Animal Industries, Moscow, Idaho. Ask for Current Information Series No. 247.

Another paying system is to carefully examine the udders and vulvas of ewes just before lambing. Mark all of those that do not show clear, positive signs of pregnancy. Keep them off feed overnight, pregnancy test, and either sell the nonpregnant ewes (depending on age, quality, past production records, etc.) or separate them and put them on a cheap, limited feed to save money and lambing space.

Pregnancy testing is also useful in accelerated lambing systems. Off-season matings usually result in lower conception rates. At 65 to 70 days after breeding ends, pregnancy test the flock and separate the pregnant and nonpregnant ewes. The pregnant ewes can then receive more attention and better feed as they approach lambing. The open ewes can be kept out on the "back 40" on a maintenance diet.

Finn x Rambouillet 12-month-old ewes rearing twin lambs.

TECHNIQUES DESCRIBED

Several alternative pregnancy testing methods are available. The Doppler and rod palpation techniques have been available for some time. Recently amplitude depth-testing devices with external probes have been developed for use on sheep.

Doppler

With the Doppler about 95% accuracy can be achieved but considerable training is required to obtain this accuracy. Some Dopplers have external probes which avoid most of the complicating factors characteristic of rectal probes. However, the technique is very time consuming and consequently has received little use in the industry.

Rod Palpation

With rod palpation accuracy ranges between 90 and 97%. Considerable training is required to obtain high accuracy with rod palpation. Ewes, which are 60 to 115 days postbreeding and have been fasted 18 to 24 hours, are restrained on their backs. Examination later in gestation than 115 days can predispose ewes to pregnancy toxemia. The hind legs should be securely held in a position so that the stomach muscles of the ewe are relaxed.

Eight ounces or more of a soapy solution (Ivory Flakes or green soap in water) is injected gently into the rectum with a drenching gun. Next, a hollow plastic rod--5/8 inch outside diameter and 21 inches in length with a bullet-shaped tip--is lubricated with the soapy solution and carefully inserted into the rectum. The soapy lubricant pushes ahead of the rod and tends to straighten out kinks in the rectum as well as lubricating so that the rod can be inserted more easily and with less chance of injury to the rectum. Do not attempt to insert rod while the ewe is straining. If the rod is initially inclined slightly toward the back bone, insertion appears to be easier. Gentle back and forth lateral movement of the outward end of the rod while exerting steady but gentle pressure facilitates insertion.

Occasionally, perhaps because of hard fecal blockage, the rod cannot be inserted without undue pressure. Too much pressure can damage the rectal lining or puncture the rectum. Rectal puncture can cause the ewe to abort or even die. Therefore, if the rod will not go in easily on the first try, use more soapy water and try again. If this fails, the ewe should either be left untested or left in a nearby pen to clean out.

A small amount of reddish mucus will frequently be seen on the palpation rod. This comes from the tender mucosal lining of the rectum and is to be expected. Relatively profuse amounts of fluid blood could indicate serious injury.

After insertion (about 14 to 16 inches, depending on the size of the ewe), the palpation rod is pressed gently but firmly upward in the posterior abdominal region where the pregnant uterus is characteristically located (see figure 1). The fetus (lamb) tends to be toward the left side or center of the abdomen. The free hand is used to feel and identify the relatively solid form of the fetus.

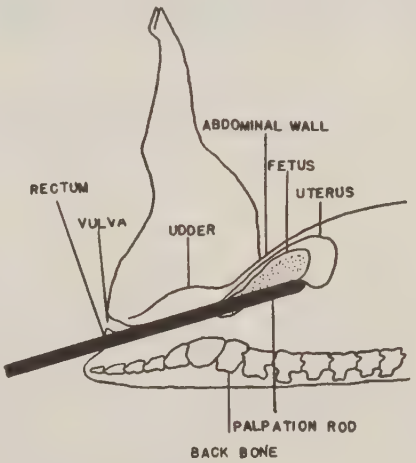


FIGURE 1. Fetus held in proper position with rod for palpation. Broad solid form of fetus can be palpated through abdominal wall.

The pregnant uterus can usually be felt by both hands, directly and indirectly, to twist and roll when manipulated with the plastic rod. If the relatively solid form and shape of a fetus is felt, the ewe is pregnant and no further examination should be made.

If no fetus is felt after examination from the extreme left to the extreme right of the posterior abdominal cavity, the ewe is not pregnant. The rod can be clearly palpated through the abdominal wall in all positions in the nonpregnant ewes.

Care should be taken to avoid sliding the rod between the uterus and the body wall, which could lead to an error in observation (see figure 2). Between examinations, the rod should be cleaned in disinfectant solution.

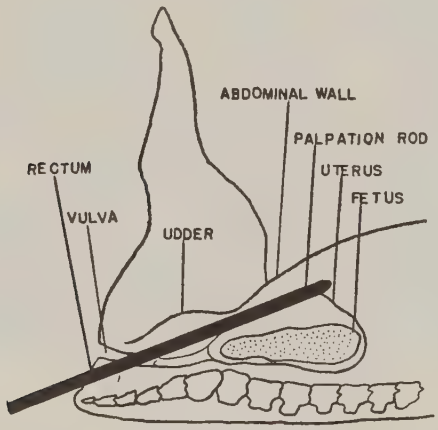


FIGURE 2. Illustration of common error made by novice. The rod may be tilted to a position ventral to the uterus by going to the right or left of the fetus and then staying ventral to it.

Although most ewes will be obviously pregnant or nonpregnant, because of biological variation the examiner will find a few cases in which he is unsure of his diagnosis. To improve accuracy, these animals should be separated and retested one week later. This should allow adequate time for growth to make the diagnosis rather certain. If no change in size or character of the suspected object occurs in one week, the ewe is probably not pregnant.

With a carousel examination cradle holder (see photos) the author--with the assistance of two wranglers, two persons loading and unloading cradles, and one person lubricating--has diagnosed pregnancy at an average of 120 ewes per hour.

Ultrasonic Amplitude Depth-Testing

Ultrasonic amplitude depth-testing devices detect the interface between the body tissues and the fetal fluids which is less time consuming than searching for fetal heartbeat or arterial pulse with Dopplers. The external probe avoids the complicating factors characteristic of rectal probes.

Ewes which are 60 to 120 days post breeding and fasted for 8 to 16 hours are restrained in the standing position so the external probe can be easily placed just in front of the udder on the righthand side in a woolless, clean area. Vegetable oil provides an airless seal between the probe and skin for good contact. The probe should be aimed slightly forward and toward the backbone unless a late stage of gestation is expected, then it is necessary to aim the probe further forward. Some training is advised to obtain proper positioning of the probe for good contact and correct diagnosis. Use of these devices with a probe which they have not been specifically calibrated for may also decrease accuracy.

Technician diagnosing pregancy using palpation technique.

Ewe in background being loaded onto cradle - another in foreground being pregnancy tested.

Accuracy ranges between 78 and 95% with the different ultrasound devices. The most common error is diagnosing open ewes pregnant perhaps due to interference from the bladder and is reflected in decreased specificity in tables 1 and 2. Even though diagnosing open ewes pregnant is less serious than diagnosing pregnant ewes open from a management viewpoint because fewer lambs will be lost, feeding open ewes as pregnant ewes reduces efficiency through increased cost and space utilization. Therefore, attempts are being made to reduce this error.

When ultrasonic amplitude depth-testing devices were compared to rod palpation too many open ewes were diagnosed pregnant with ultrasound devices while too many pregnant ewes were diagnosed open with rod palpation (table 5). More recently

TABLE 5. Evaluation of accuracy of diagnosis for pregnancy in ewes with Pregmatic II and Rod Palpation

	Pregmatic II	Rod
Overall Accuracy (%)	94.8	92.6
Sensitivity (%)	97.2	87.6
Specificity (%)	93.1	96.1

N = 347 ewe lambs bred 60 to 118 days before diagnosis

Pregnancy rate = 41.2%

Sensitivity = $\frac{\text{Total correctly diagnosed pregnant}}{\text{Total lambing}}$

Specificity = $\frac{\text{Total correctly diagnosed nonpregnant}}{\text{Total not lambing}}$

TABLE 6. Evaluation of accuracy of diagnosis for pregnancy in ewes with three ultrasonic amplitude depth-testing devices and rod palpation

	Pregmatic III	Pregtone	Scanopreg II	Rod
Overall Accuracy (%)	85.5	87.2	77.6	95.2
Sensitivity (%)	99.3	98.6	100	91.6
Specificity (%)	75.6	79.4	62.2	97.6

N = 352 ewes tested at 70 to 145 days post breeding

Pregnancy rate = 40.6%

we compared several ultrasound devices and rod palpation. Similar trends were observed as in previous trials (table 6).

With elevated examination platforms the operator--with the assistance of two wranglers and one person stopping the ewes monentarily--has diagnosed pregnancy in 100 to 140 ewes per hour. Thus amplitude depth-testing devices coupled with elevated examination platforms show promise of offering labor efficient, low stress system of pregnancy testing sheep. The devices are being modified and evaluated to increase accuracy.

The elevated examination platforms aid in restraint of the ewe in the standing position so the operator can easily locate the proper position for the probe in a clean, woolless area just in front of the udder on the ewes righthand side.

Note the 2 x 10" board which runs the length of the platform in the upright position. It allows pregnancy testing, even if the ewe tries to lie down.

ARTIFICIAL REARING OF LAMBS

Extra or orphan lambs occur in almost all sheep flocks at lambing time. These are lambs that ewes cannot rear and result from quadruplets, triplets, twins from ewes with borderline milk production, or from ewes that die. As the sheep industry adopts the use of more prolific sheep breeds and increased lambing frequency, the number of extra or orphan lambs will increase. Unless such lambs can be reared by artificial means, potential lamb meat for human consumption and income to the sheep industry is lost.

Recent research here shows that newborn lambs can be successfully reared using milk replacer diets, labor-free self-feeding devices, and early weaning from liquid diets. Current research is aimed at improving diets, equipment, management, and disease control in rearing lambs artificially from birth to market weight.

MILK FEEDING PERIOD

Young lambs require a liquid milk diet until stomach development is sufficient to digest solid

feeds. Newborn lambs must receive colostrum milk. When this cannot be obtained from the ewes, we have found that cow's colostrum obtained ahead of time can be frozen, thawed out at room temperature, and fed (4 to 6 ounces each 4 to 6 hours over the first 18 to 24 hours). Our studies also show colostrum can be freeze-dried for storage, then reconstituted with water for feeding.

Following colostrum milk feeding, the lambs can be self-fed a milk replacer formula. Earlier studies indicate low-fat and low-protein calf milk replacers containing high levels of dried whey are not satisfactory for lambs. Milk replacer formulas used with greatest success contain 30 to 32% crude fat, 22 to 24% crude protein (milk protein), 0 to 1% crude fiber, 5 to 10% ash, and 22 to 25% lactose with added vitamins and trace minerals. The milk replacer powder must remain in solution after mixing with water.

Milk products used in preparing milk replacer formulas have rapidly escalated in price in recent years. Therefore, research is being conducted to determine the possibility of using plant and whey protein concentrates in lamb milk replacer diets to reduce feed costs. To date no good substitute has been found.

Earlier studies show that overall lamb performance is more satisfactory on cold than on warm liquid self-fed milk replacer diets. Lambs consume a small amount of the cold milk solution at each nursing, but nurse often. This reduces overeating and digestive problems. Keeping the milk cold also prevents its souring in feeding containers.

Milk replacer powder (30% fat) mixed at the rate of 2 or 2 1/2 pounds per gallon of warm water results in a solution similar to ewes milk in total fat and solids. Immediate cooling to 33° F tends to eliminate ingredient separation in storage and feed containers. In a free-choice feeding system, each lamb consumes 1/2 to 3/4 pound of milk replacer powder in solution daily (2 to 4 pints of the liquid).

Consumption of solid feed, in addition to liquid milk replacer, aids in stomach (rumen) development in the young lamb, which is essential when early weaning (at 4 weeks) from the liquid diet is accomplished. Thus, concentrate fed in pellet or loose mix form and good-quality alfalfa hay should be offered during the milk-feeding period. Also, trace mineral salt and drinking water should be available free-choice. Studies are being conducted on feed additives that possibly will stimulate rumen development in young lambs to allow earlier removal of lambs from liquid diet feeding, and, thus, reduce feeding costs.

Reasonable success has been achieved in protecting against overeating disease (enterotoxemia) by vaccinating orphan lambs with Clostridium perfringens Type C and D, toxoid when removed from the ewe, again 10 days later, and at the end of the milk feeding period. The incidence of "white muscle" disease can be reduced by injecting the lambs with the recommended level of selenium-tocopherol at the start of the milk-feeding period.

EQUIPMENT

The type of equipment needed to prepare and feed milk replacer solution is determined by the number of lambs to be fed and the degree of automation desired.

For a small number of lambs, the milk powder and water can be mixed with an egg beater or electric hand mixer. However, for a large number of lambs, a conventional agitator-type washing machine or electric paint stirrer is satisfactory. Commercial mixers are also available. A 24-hour supply of milk solution can be prepared once a day and refrigerated until needed.

Orphan lambs in nursing training pens. Lam-Bar nipples inserted through holes of metal plate mounted on side of pen, with siphon tubes leading to insulated lunch box, serves as milk feeder.

To minimize labor and to promote maximum growth, the lambs should feed themselves on a free-choice basis. Lam-Bar nipples and tubes attached to a heavy plastic vat mounted in a plywood frame and installed in the lamb pens is a satisfactory feeding device. The nipples are 14 to 15 inches above the floor or ground level. Cold milk should be available in the vats at all times. Plastic jugs filled with water and frozen to ice can be placed in the

Lambs being artificially reared in self-sufficient pens on a thermochest milk replacer feeder.

vats to keep the milk temperature low in warm weather. A similar self-feeding device consists of Lam-Bar nipples attached through holes in a metal bar (with baffles to prevent nipple chewing) mounted on the side of the lamb panel. Nipple tubes lead to a plastic lined, insulated, thermochest outside the pen panel. Substitution of a small insulated container for the large thermochest converts this feeder for use in nursing training pens, as the more shallow container holds the milk near the nipple level making it easier for the lambs to obtain milk.

An efficient pen arrangement for artificial rearing of lambs using thermochest milk feeders and reach through troughs for solid feeds and water.

Another milk feeding system we have developed for large number of lambs consists of Lam-Bar nipples and tubes attached through holes in a metal bar (with baffles) mounted on a wooden framework alongside a 3- or 4-inch-diameter polyvinylchloride (PVC) pipe, which serves as a milk reservoir. The nipple tubes lead to the pipe containing the liquid milk replacer. Milk from a refrigerated bulk tank flows by gravity through a plastic tube to the feeder pipe and is regulated by a liquid-level control valve, developed for ease of cleaning and operation. On any of the above feeding units, an allowance of three to five lambs per nipple is satisfactory. Lambs can be fed in groups of 25, but performance is more satisfactory in groups of 15 or less.

Research is being conducted on a fully automated system of milk replacer preparation, storing, and feeding.

Although the exact temperature for artificial rearing facilities has not been established, some research shows that lambs perform better in warm (68°F) than in cold (10°F) environments. Warmth can be provided by mounting infrared (110 volt, 250 watt) heat lamps with reflectors about 30 inches above the pen floor (one lamp for each 15 lambs). Quartz-type infrared heat lamps, installed according to manufacturer recommendations, can also be used. Solid floor pens are bedded with straw or wood shavings. Expanded metal or slotted floors reduce pen-cleaning requirements when 4 1/2 square feet of floor space is allowed per lamb. A greater floor space requirement is necessary on solid floors. To reduce incidence of coccidiosis, all feeders and waterers should be designed to keep lambs feet out of them. Pens and feeding equipment should be kept clean.

Refrigerated storage tank automatically dispenses cold liquid milk replacer by gravity into a pipeline feeder by use of an electronic controller, electric valve and liquid level electrodes in pipeline. This system was developed for feeding large numbers of orphan lambs.

Lambs nursing on Lam-Bar nipples of the pipeline feeding system. A second pipeline feeder is shown in the background.

POSTWEANING PERIOD

Lambs can be weaned from milk feeding when they reach 4 to 5 weeks of age and are consuming some solid feed. Lambs weaned either abruptly or gradually at this early age receive a slight growth check for about one week, which is seldom permanent. This is due to a failure to consume sufficient solid feed during the adjustment period. Studies are being made of solid diets to alleviate this postweaning growth check.

Recent studies show that, until the lambs reach 45 pounds body weight (about 9 weeks of age), the postweaning diet should be high in crude protein (17 to 20%) and digestible energy (1.20 to 1.40 megacalories per pound of feed), but low in roughage (below 23%) for maximum growth when confined to the drylot. Thereafter, lambs can be fed to slaughter weight on any standard fattening diet in the drylot.

Mechanized feeding of pelleted alfalfa during winter saves labor and controls consumption.

WINTER FEEDING OF SHEEP

Winter feeding is one of the largest expenses for most ranchers. Baled or loaf stack hay is commonly fed to sheep in feeders or on the ground. This method of feeding has inherent disadvantages such as excess wastage and increased incidence of disease. Station records indicate a 30% loss of hay fed due to selective feeding and trampling. In addition, a high incidence of vibriosis has also been associated with this method of feeding. Because of the above circumstances and because feeding pellets requires less labor, transportation, and storage costs, and improves feed intake, feed efficiency, growth rate, and wool growth, the feeding of pelleted alfalfa hay has become standard practice in the winter feeding of our sheep. However, pelleted alfalfa hay has become very expensive in recent years. Cubing of alfalfa hay is one of the more recent techniques in harvesting and processing forage. It is a much cheaper process than pelleting. The large 1 1/4 inch alfalfa cubes should be crushed before feeding and then only fed to adult sheep. Alternatively, the water intake required to make the cubes can be reduced, thereby effectively reducing the size and hardness of the cubes. Other alfalfa cubes, measuring 1/2 by 1 by 2 inches, may soon be on the market and appear to be ideally suited for feeding to lambs or older sheep. Chopped alfalfa hay may also be fed to adult ewes and their performance is equal to similar ewes fed equal (3-4 lbs/animal/day) amounts of alfalfa pellets.

FEED LEVELS FOR EWES DURING GESTATION AND LACTATION

Results of studies at this Station have shown that a 140-pound ewe's intake of alfalfa should be about 3.2 pounds until 6 weeks before lambing, and about 4.2 pounds from then until lambing. Thin ewes should be fed more. After lambing and before grazing starts, the ewes require high levels of feeding to maintain milk production. We recommend a feed intake of 6 pounds alfalfa pellets per ewe per day for ewes with singles and 7 pounds alfalfa pellets per ewe per day for ewes with twins, after lambing.

Self-feeding alfalfa pellets to lactating ewes saves labor but increases feed costs.

FEEDING STRAW TO ADULT SHEEP

Because of rising alfalfa hay costs and possible hay shortages, the use of straws as the source of roughage in the rations of adult sheep is important. Research conducted at the U.S.S.E.S. has shown that adult ewes will maintain weight on a ration (3-4 lbs/animal/day) of 50% chopped straw, 35% cull beans or peas, 14% liquid molasses, 0.5% trace mineral salt and 0.5% vitamin complex but lost weight on a similar diet without the molasses.

Limit-feeding alfalfa pellets to lactating ewes can reduce feed costs.

FEEDING CULL BEANS OR CULL PEAS

Beans and peas are grown extensively in the Northwest. Cull beans and peas are the cracked, split, and diseased seeds of the industry and are a valuable cheap feed for livestock, containing from 22 to 24% protein. Studies at this Station have shown that cull beans can profitably replace up to 15% of an alfalfa-barley diet. Yearling ewes will readily consume at least 20% of their diet as cull beans when fed alfalfa pellets as the roughage. Adult pregnant ewes will consume up to 44% of their alfalfa diet as cull beans without any apparent ill effects. Other studies have shown that cubed pea straw (56%) and raw cull beans (44%) appear to be an adequate diet for pregnant ewes.

Lambs fed alfalfa pellets and cull peas made significantly better gains than lambs self-fed alfalfa pellets and loose barley. Cull peas are also very suitable for pregnant ewes and may comprise up to 44% of their ration without any ill effects. However, peas are highly deficient in sodium and marginal in selenium. Hence, adequate salt must be fed and selenium injected.

EARLY WEANING OF LAMBS IN FEEDLOT

To facilitate early rebreeding of ewes on accelerated lambing programs, lambs have been early weaned at 31 and 41 days of age and fed concentrate diets in the initial post weaning period. Good results have been obtained with a ground corn or barley (59%), soybean meal (23%), alfalfa meal (15%), limestone (1.8%), trace mineral salt (0.5%), vitamin complex (0.5%) diet. Alfalfa pellets and whole barley are fed in the third and fourth weeks and comprise the whole diet by the sixth and seventh weeks. Lambs should be conditioned to the early weaning diet before weaning.

EARLY WEANING OF LAMBS OFF SPRING-FALL RANGE

Sheep numbers on the summer rangelands of the Intermountain Region have been reduced in recent years due to pressures for wildlife, recreation, and watershed protection. Because of these considerations and the increasing predator loss on summer rangelands, it has become advantageous to investigate various management systems aimed at reducing dependence on the mountain summer range. One of these systems is the summer grazing of sagebrush range by ewes and the early weaning of their lambs. This system was investigated at our station for 7 consecutive years. Half the lambs of large numbers of ewes (325) were weaned at average age of 75 days and self-fed 62.5% alfalfa - 37.5% barley pellets and their dams were grazed on sagebrush grass range for the summer season. The other half of the lambs went to the summer range with their dams. No significant differences were found in the performance of the early weaned lambs as compared with late-weaned lambs. Hence, it appears that summer grazing of sagebrush grass range by ewes is a reasonable alternative to grazing high mountain range, and early weaning of their lambs is practical under these circumstances.

BABY LAMB SURVIVAL

Cause of death studies have provided insight into management weaknesses responsible for death in lambs from birth to 30 days of age. Information from approximately 800 necropsies showed that starvation, scours (Colibacillosis), and pneumonia accounted for almost 75% of all baby lamb deaths. Most starvation losses occurred during the first 72 hours after birth and were due to lack of effort in assuring that all lambs suckled soon after birth. High loss to scours and pneumonia resulted from not regularly observing all lambs and appropriately treating sick lambs and by turning ewes with lambs out of sheds before the lambs were 3 days old. All lambs, in sheds and in mixing pens, should be observed every day for signs of illness until the lambs are at least 2 weeks old. Good response to treatment for scours or pneumonia can usually be expected if the condition is diagnosed early, when the lamb is still relatively vigorous. However, if lambs are turned outside before they are 3 days old, environmental stress (such as adverse weather) will lower the resistance of the lamb, and high losses from pneumonia and scours can be expected. Early turnout also results in more mismothering and starvation. Young chilled lambs (under 3 days) quickly lose body temperature, stop nursing, and soon die. So that ewes and lambs can be confined in sheds for the recommended period, a ratio of at least one jug (pen) for every 10 ewes lambing is necessary. One jug for every 8 ewes lambing is recommended to compensate for peak lambing periods.

Effective treatment and vaccination program recommendations vary with individual farm health problems. When problems arise, consult a veterinarian experienced in dealing with sheep diseases.

Grafting stanchion used for grafting on extra lambs.

HOW TO PUT LAMBS WHERE THE MILK IS

Almost a million lambs are lost each year as a result of starvation; they simply don't get enough milk from their mothers to survive.

In recent years, interest has increased in rearing these lambs artificially on liquid milk replacer diets; however, the cost of milk replacer, equipment, and labor frequently is so high that

there is little, if any, profit left for the sheepman. While some lambs are starving, other ewes have a large surplus of milk. We believe that the most economical way to raise most of those "extra lambs" is on ewes with surplus milk. The problem is to get the ewes to agree to the proposition.

Most sheep ranchers are well acquainted with "slime grafting," "wet grafting," and "skin grafting," often accomplished by tying or haltering. Each has its place and time.

Slime grafting can be done very easily and successfully immediately after birth while the newborn lambs is still slimy wet and there are lots of placental fluids and membranes available to completely cover and soak the "extra lamb" before the mother has thoroughly identified her own offspring. The sooner the graft is made after birth, the greater the chance of success. Once the newborn lamb starts to dry and the ewe has become acquainted with it, the chance for success is slim.

Wet grafting is a technique that can be used to take over where slime grafting leaves off. The ewe's own lamb, although still very new, is too dry to provide enough slime for grafting. Both the ewe's own lamb and the "extra lamb" needing a milk supply are completely immersed in a salt water solution. The lambs are then thoroughly rubbed together, and the "extra lamb" also rubbed with any placental membranes that might be available. After this procedure, some lambs may be rejected. Therefore, the new family must be put in a maternity pen or jug and observed carefully until a firm mother-offspring bond is established with both lambs.

Skin grafting. When a ewe loses her own lamb through accident or disease, the lamb can be skinned and the pelt slipped onto the "extra lamb" which needs a milk supply. The head, legs and tail of the graft are smeared with the blood and body fluids of the dead lamb. Some of these skin grafts are quickly successful, but others require tying the ewe in the pen for several days before she will adopt the new lamb.

Stanchion grafting. All too frequently, a ewe with only one lamb but adequate milk to rear two lambs is not identified soon enough to use either slime or wet grafting; or a ewe with twins and an adequate milk supply loses one lamb. Because it has not been possible to use the extra milk, it has been necessary to resort to rearing the "extra lambs" artificially, with very expensive, labor-intensive, milk replacer systems.

Can the "extra milk" some ewes have be used to raise these lambs and, if so, how? How long will it take to make a successful graft? A study conducted at the U.S. Sheep Experiment Station answers these questions.

Stanchions can be constructed out of lumber or 3/4 inch square metal tubing and 1/2 inch pipe and designed to fit in a 4- by 5-foot lambing jug (see page 13) in such a way that the ewe has access to a PVC pipe watering device and can be easily fed a pellet diet. A middle leg can be added to the steel stanchion to prevent the ewe from getting under and lifting the sides up. The steel stanchions are easily removed from the jugs when not needed.

Persons assigned to suckling and grafting duties should graft as many lambs as possible using slime, wet, and skin grafting techniques. In addition, they should identify every ewe that has only one lamb but adequate milk for two lambs but cannot be successfully grafted to, using the other available techniques. These ewes are then placed in stanchions with their own single lamb as quickly as they are identified, and the "extra lambs" needing a milk supply are matched for size and vigor with the ewe's own lamb in such a way as to get the best possible match. No attempt needs to be made to modify the smell of the "extra lamb," nor is suckling usually necessary.

The stanchion should be designed so that the ewes can lie down or stand, as they desire, but their heads are held so that they cannot turn to see the lambs or to smell the lambs.

It usually requires 4 or 5 days to establish a good graft. The younger the lambs and the more recently the ewe has lambed the less time required. Relatively old lambs may require 5 to 10 days. The ewes and lambs should be observed closely for acceptance behavior and thriftiness. As soon as it appears that a good relationship exists, the ewe and lambs should be placed in a trial jug where the ewe is completely free to observe and suckle her lambs. The new family should be left in this trial situation for 1 or 2 days. If acceptance appears good, the ewe and lambs are turned out into a mixing pen with other ewes and lambs and are managed as all other sheep. With good management, one can expect a success rate of about 85%.

Public rangeland grazing fees are based on the number of ewes. The charge is the same whether the ewe has one lamb or two. The saving in feed costs on each stanchion-grafted lamb, when compared with costs on an artificially reared lamb, was from $22.15 to $30.25 per head.

Esophogeal-fistulated wethers and wethers wearing fecal collection bags provide samples for efficiently measuring the value of range forage.

GRAZING ON SPRING AND SUMMER RANGES

The quality of forage on the spring and summer ranges is important to the growth of the lambs up to weaning. Digestion trials were conducted for several years on the subalpine summer range. For this work, yearling wethers with an opening (fistula) into the esophagus are used to collect samples of the forage eaten. The fistula is closed with a plastic cap when collections are not being made. Other wethers have canvas bags strapped on them to collect the excreta. By measuring the content of

an indigestible plant material (lignin) in the forage samples and in the excreta, the amount of forage eaten and its digestibility can be calculated. On the summer range, these yearling wethers have averaged 3.0 to 3.4 pounds of forage dry matter intake per day, with 60 to 66% digestibility. The same technique was recently used on the sagebrush-bunchgrass spring range. Average intake of organic matter (mineral-free) ranged from 4.3 pounds in early May, to 2.8 pounds in mid-June, with digestibility declining from 80 to 65% during this time.

Along with using these esophageal-fistulated sheep to determine digestibility of the range forage, portions of the fistula samples are examined under a microscope to identify the various plants eaten by the sheep, and the relative frequency of each type of plant in the diet. This information is very helpful in managing the range for the most desirable and productive plants.

Wether wearing bag for collecting eaten forage extruded through an esophogeal fistula.

RANGE RESEARCH

The primary goal of range research at the Station is to improve the quality and quantity of forage for sheep consistent with good management practices for other resources. In our area, sheep graze sagebrush-grass ranges during the spring and fall, and are trailed to higher elevation grass-forb ranges for the summer. In combination, these ranges provide adequate forage for the number of sheep currently being produced. Developing ways to increase forage will result in greater red meat production from these ranges in line with national goals.

A forage improvement program for rangelands involves a number of factors: (1) Selecting methods to increase the proportion of desirable plants, while reducing competition from less desirable species; (2) introducing higher quality, higher yielding forages, either native, introduced, or genetically improved; (3) increasing the nutrient content and yields by fertilization where economical; and (4) developing grazing systems that optimize forage quality and quantity as expressed by red meat production. In 1977, a range research program was initiated to improve forage on sagebrush-grass and high elevation sheep range.

SAGEBRUSH BURNING

Past research conducted here and elsewhere has shown that spraying herbicides; mechanical eradication using railing, plowing, and rotobeating techniques; grazing; and burning are effective ways to reduce competition from sagebrush permitting an increase in forage. Even though effective for removing sagebrush, in certain situations, some techniques have undesirable features.

Herbicides are generally nonselective, killing all woody, weedy, or grass plants as a group. Spraying sagebrush often results in a reduction of desirable forbs, which are vital to young sage-grouse and sheep alike. Mechanical treatments are costly and usable only where the terrain permits. Heavy sheep grazing in the fall results in an increase in desirable forage, but in heavily sagebrush infested range, the change is slow. Considering these and other factors, burning is favored as a conversion technique when the following conditions prevail:

- Where fires can and will be controlled.
- Where the principal use of the area is for livestock grazing.
- Where soils are fairly firm and slopes are less than 30%.
- Where sagebrush is dense and forms more than a third of the plant cover.
- Where fire-resistant perennial grasses and forbs form more than 20% of the plant cover; or if they form less than 20%, where reseeding to perennial species is practicable.
- Where proper grazing practices can and will be used after burning.

Current research is being directed towards spring burning as a practice, because weather conditions in the spring make the fire easier to control without expensive fireline construction as needed with late summer burns. Spring burning is being evaluated to determine the effects on vegetal yields and quality; return of undesirable sagebrush and poisonous horsebrush; damage to desirable perennial grasses and forbs; influence on the habits of sage grouse, other birds, and small mammals; and effect of sheep grazing after burning.

GRAZING SYSTEMS FOR SAGEBRUSH-GRASS SHEEP RANGE

Previous studies show that rotation grazing is beneficial to sagebrush-grass range. Repeated, heavy spring grazing causes a decline in desirable plants; whereas, heavy fall grazing has an opposite effect. A rotation system that allows alternate spring and fall use, or a deferred rotation system that uses only part of the spring range early and the other part late, changing the pattern each year and alternating between spring and fall, are good improvement techniques.

Many sheep operators do not have summer range available, and are restricted to grazing sagebrush-grass range solely, or have pastures available for summer use. A system is being developed, and will be tested for season-long use (May to mid-September), on sagebrush-grass ranges. Indications are that ewes early weaned of their lambs can be maintained during the summer season. The rotation system proposed for testing will be superimposed over improved range (spring burned) and unimproved range. The effects of the system on both lamb and ewe performance and vegetation responses will be evaluated.

Heavy grazing in the fall only (left) improves range quality, whereas heavy grazing in the spring (right) reduces grasses and forbes, and increases sagebrush.

IMPROVED PLANT SPECIES

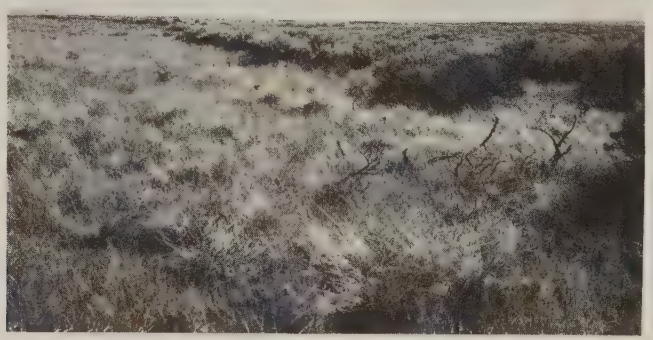
For many years, a wide variety of native and introduced grasses and forbs were planted at and near the Station to test their adaptability to our climate. Certain species, like crested wheatgrass, desert wheatgrass, and Siberian wheatgrass, have been recommended for reseeding on depleted ranges. Although these species are adapted and productive, other species are preferred by sheep. We are testing some of the newer, improved grass lines for germination, establishment, adaptability, nutrient content and yield, preference by sheep, and ability to compete with other native range plants.

SUMMER RANGE

Nutrition studies on high-elevation sheep range revealed that sheep ate less grasses and sedges as the season progessed. Two forbs, pale agoseris and mountain sorrel, were highly preferred, but are not abundant on the range. Certain other species that sheep prefer are also scarce. These facts suggest that research needs to be conducted on ways to increase these valuable species.

We are planning studies to do just that. Initially, certain species known to be preferred will be collected and analyzed for energy, protein, and nutrient contents. Diet studies will be conducted, in different vegetation types, to determine species preference under various conditions and nutritive values. The response of these species to grazing will indicate their ability to withstand grazing pressures. After the nutritious and resistant species are identified, we will develop techniques to seed these into the existing range.

Grazing management will be studied, and new and improved plant species will be tested for adaptability and usefulness in the high country. Fertilization will be assessed as a means of economically increasing yields and quality.

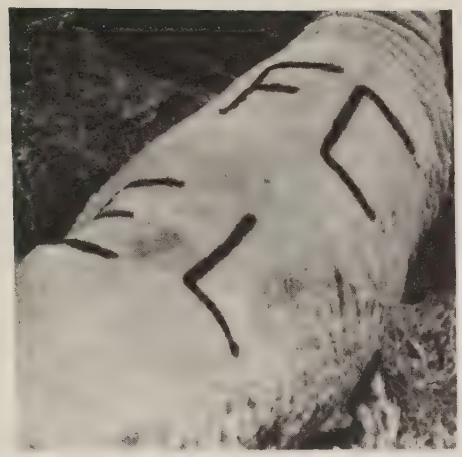


A properly controlled burn can greatly increase forage production.

WOOL RESEARCH

WOOL VALUE

The price of wool depends mainly on clean yield, staple length, and fiber diameter. The amount of clean fiber present can be determined scientifically by the core test. Total staple length is frequently measured by parting the wool at a designated area on the animal and measuring with a ruler from the skin surface to the tip. Fine staple wool (2 1/2 inches and longer) has sold for 9 cents per greasy pound more than fine French wool (under 2 1/2 inches in length). Dye-stripes may be applied to fleeces to record seasonal pattern of wool growth or to mark the occurrence of particular events such as mating, parturition, lactation, and weaning. Generally, the finer the diameter of the wool fiber, the better the price obtained for the wool. Fineness can be measured both visually and by the micron test.



A branding fluid can be both scourable and legible.

SCOURABLE BRANDING FLUIDS

Generally, legibility of brands decreased with scourability of fluids; however, scourable fluids exhibited brands legible enough for practical use. Black color was superior to any other color. Finer wool tended to produce more legible brands than coarse wool. An increase in staple length was accompanied by a decrease in legible brands. Environment influences legibility of brands.

PLASTIC BALER TWINE

Many woolen mills will totally reject wool clips containing even small amounts of plastic baler twine. This twine cannot be degraded by the various processing procedures and may spoil finished fabrics. Hence, we recommend strongly that sheepmen refrain from using hay baled with plastic twine. The alternative is to very carefully remove all twine when bales are broken and place them in a barrel for burning. Also remove small cut ends.

WOOL POOLS

To determine the discounts normally assessed on faulty and contaminated wools, buyers from mills and wool-buying companies were contacted. The data obtained is based on 90¢/lb greasy fleece wool and the amounts given in table 6 are the discounts assessed and not the actual prices/lb greasy paid for the wools.

DISCOUNTS ASSESSED ON FAULTY WOOLS

To facilitate the marketing of farm flock clips of greasy wool, many growers have organized county and statewide wool pools. Large volumes of wool can thus be accumulated and prepared in a more attractive and desirable condition to the wool industry. Wool thus prepared has increased the return to sheep ranchers.

WOOL PREPARATION

The large sheep rancher should grade wool into lots according to visual fineness. Over the years, this policy will build a reputation with the industry and insure maximum prices for the wool. The small sheep rancher should at least remove tags, crutchings, and colored wool from fleece wool. Good wool preparation entails separating tags, crutchings, colored, unscourable, sandy, kempy, and dead wools from fleece wools.

TABLE 7. Discounts assessed on faulty and contaminated wools

Type of Fault or Contamination	Discounts (in cents/lb greasy)
Synthetic twine in wool	24
Colored wools	30
Stained wools:	
Yellow	14
Very yellow	21
Tar	20
Non-scourable branding fluid	11
Burrs, straw (wt.) in wool:	
1-3%	4
3-7%	11
7-12%	21
Tags:	
#1	57
#2	64
Crutchings:	
#1	47
#2	52
Snort wool	20
Ram wool	20
Wet wool	32
Dead wool	32
Cotted wool	25
Hairy and kempy wool	28

CURRENT RESEARCH

Research is in progress to determine the wool characteristics of Polypay and Finn-cross sheep and to determine the usefulness of these wools in the production of quality fabrics. Preliminary results suggest that they have satisfactory spinning characteristics.

VETERINARY MEDICINE

DISEASE RESEARCH

Cooperative disease research is conducted between the U.S. Sheep Experiment Station and various research institutions, including the Department of Veterinary Science, University of Idaho; Veterinary Research Laboratory, Montana State University; College of Veterinary Medicine, Washington State University; and the Pioneering Research Laboratory, USDA, SEA. Disease research priorities are determined by the prevalence of a particular health problem and the extent to which the disease causes economic loss to the sheep industry. In the following paragraphs, results from some of the recent or current sheep disease research conducted at the Station are reviewed.

Coccidiosis

Coccidiosis is a protozoan infection of the intestinal tract. The disease is widespread and commonly occurs in lambs reared in confinement and on feedlots. The disease generally results in diarrhea, reduced weight gains, inefficient feed utilization, a generalized depressed condition, and, sometimes, death in heavily infected animals. In comparison to coccidiosis in cattle, limited research has been conducted to evaluate new drugs to effectively and economically control coccidiosis in sheep.

A research project was completed in 1977 in which two antibiotics, lasalocid sodium and rumensin sodium, were tested for coccidiostatic activity

Veterinary medical students attend Sheep Station each year for training in sheep diseases and management.

in lambs experimentally infected with coccidia. Each drug was incorporated directly into barley alfalfa pellets. Rumensin sodium was mixed at the rate of 15 grams per ton of feed and lasalocid sodium was mixed at the rate of 91 grams per ton of feed. During a 65-day trial period, untreated control lambs gained 0.542 pound per day compared with 0.749 pound per day for lambs fed pellets containing lasalocid or rumensin sodium. At the conclusion of the trial, the weight of the untreated control lambs averaged 81 pounds as compared with 96 pounds for treated lambs. Feed consumed for each pound of gain for untreated controls was 5.76 pounds; treated lambs, 4.83 pounds. There were no differences in performance (rate or efficiency of gain) of lambs treated with lasalocid or rumensin sodium. Following the experimental infection of all lambs, untreated lambs showed signs of clinical coccidiosis; whereas treated lambs remained healthy throughout the trial.

More recently coccidiosis in young lambs has been effectively controlled by feeding lasalocid sodium mixed with mineral salt at a rate of 7480 ppm. Rate and efficiency of gain was significantly greater in lasalocid salt treated lambs than in untreated lambs. This provides a very inexpensive, labor efficient method of preventing the losses and lowered performance associated with coccidiosis and should markedly improve efficiency of production where coccidiosis has been a major problem in the past.

Colibacillosis (Scours)

Scours, one of the major causes of death in lambs from birth to 2 weeks of age, is the focus of a major research effort. Samples are being collected from scouring lambs in the intermountain region. Different strains of bacteria that cause scours are being identified. Major disease-causing strains have been combined in a vaccine which has been tested in pregnant ewes. The vaccine was found effective. Further refinements, testing and evaluations are being done this year.

Ovine Progressive Pneumonia (Lunger Disease)

Ovine progressive pneumonia (OPP) is a virus-caused respiratory disease of mature sheep that is characterized by gradual and progressive weight loss, difficult breathing, and eventual death. A testing program for OPP was completed in 1977. Blood samples were collected from approximately 3,000 sheep from different flocks across Idaho. The results show that OPP is more prevalent in Idaho than we had suspected, ranging from 58% for all ages combined in one flock to 90% of 6-year-old cull ewes in another flock. Overall incidence was determined largely by age, rising from 16% in yearlings to 83% in ewes 7 years old and older. Rambouillets and Dorset x Targhee had less evidence of infection than five other breeds. Only a small percentage of infected sheep show symptoms of the disease (labored breathing and weight loss). Infected sheep, until they develop the lunger condition, have been shown to be just as productive as noninfected sheep.

Thin Ewe Syndrome

Thin ewe syndrome (TES), a condition affecting mature ewes, is characterized primarily by emaciation. In an average flock, having normal age distribution, 2 to 3% of the ewes may fall into the TES category. The incidence of TES increases with age although 2- and 3-year-old ewes can be effected.

TES is caused by at least three types of infections, two of which are bacterial in origin and the third is viral in origin (internal caseous lymphadenitis, Corynebacterium pyogenes infections, and ovine progressive pneumonia). All three of the infections are chronic and may lead to progressive weight loss and death. Debilitation, emaciation, and possible respiratory distress are the only symptoms of TES.

TES is economically important because it reduces reproductive efficiency in affected animals. Because TES causes early death, many of these ewes die before reaching the normally expected productive lifespan. Reduced fertility is commonly observed in TES ewes and results in a high percentage of nonpregnant ewes. As many as a third of TES ewes may be nonpregnant. Fewer lambs born and fewer live births are also associated with TES. The most profound effect of TES on reproductive efficiency is the decreased number of pounds of lamb weaned per ewe bred (table 8). The differential in pounds of lamb weaned per ewe bred for Rambouillets (39.9 versus 66.0) is a 65% increase in favor of

normal ewes. Targhee and Columbia ewes show the same pattern, from 50.2 to 73.5 pounds (46% increase) and from 26.6 to 61.7 pounds (132% increase), respectively, in favor of normal ewes.

TES is a major cause of reproductive failure and is not associated with previously described pathological or functional disorders of the reproductive system. The exact reason for lowered reproductive efficiency is unknown although researchers assume that prolonged disease-induced stress and the associated emaciation are primary contributing factors.

TABLE 8. Comparison of lamb production between TES and normal ewes

Breed	Pounds of lamb weaned per ewe bred	
	TES ewes	Normal ewes
Rambouillet	39.9	66.0
Targhee	50.2	73.5
Columbia	26.6	61.7

TES is caused by several diseases for which diagnostic technology has not been developed or for which effective therapeutic measures are unavailable; therefore, the only present means of control is to cull TES animals from the flock. Retention of such animals will undoubtedly serve as a reservoir of disease from which other sheep could become infected. The significant reduction in pounds of lamb weaned per ewe bred is additional justification for culling because TES ewes fail to provide sufficient economic return to pay production costs.

VETERINARY MEDICAL EDUCATION

The U.S. Sheep Experiment Station, in cooperation with the Washington State University Northwest College of Veterinary Medicine, offers specialized training in sheep diseases and management to senior veterinary medical students. This program is intended to provide training and experience related to sheep industry problems that could not otherwise be available to the veterinary students. As a result of this experience, these graduating veterinarians will be better qualified to cope with disease and management problems confronting the sheep industry.

PREDATOR RESEARCH

An immature male Hungarian Komondor assuming guarding responsibility for a band of range sheep.

An executive order in 1972 removed poisoning from the arsenal of weapons available to sheep producers to control coyote predation of their stock. Since that time, the Federal government and others have been conducting research to find alternatives to the traditional lethal control techniques--trapping, denning, M-44's, aerial and sport hunting. Predator research at the Sheep Station began in 1974 and currently involves four full-time employees and facilities for housing and maintaining over 150 coyotes.

Electric, anti-coyote fencing, developed and field tested here in 1977, now can provide effective, practical protection to farm flocks and sheep on fenced range. This technology is considered to be a major development for protecting sheep from coyotes and is in use throughout the country. Electric antipredator fencing has widespread but not universal application. As past history shows, an array of tactics to reduce predator losses to acceptable levels is necessary as terrain, management systems, people preferences and degrees of predation vary from one area to another. In particular, the range sheep industry is hard hit by predators in some locations. One-half of the commercial sheep produced in the Western United States graze on Federal ranges where electric fencing is impractical.

In late 1977, a project was begun to evaluate the use of livestock guarding dogs to protect sheep from predators. Although relatively new in this country, dogs were used for centuries in Europe and Asia to keep wolves, bears and other predators from livestock. The Great Pyrenees of France and Spain, the Kuvasz and Komondor of Hungary, the Maremma of Italy, the Shar Planinetz of Yugoslavia and the Karabash of Turkey all reportedly were bred and used to protect the flocks of the shepherds. The Komondor was initially selected for study at Dubois, and in late 1979, Great Pyrenees were added to the research. In general terms, young pups are placed with sheep and remain with sheep as much as possible throughout the dog's maturation, which may take from 1½ to 3 years. The pups are closely observed during their stay with sheep to insure that the sheep do not injure the dogs and that the dogs do not play with the sheep. Dogs being playful with sheep is a relatively common problem and must be immediately corrected. Dogs receive daily human attention and (rather) informal obedience lessons are given frequently. The dogs must be controllable.

The guard dog research to date has indicated several points: (1) No one breed of dog is currently thought to be the best for predator control; (2) dogs should be purchased from a reputable breeder--one who knows about the dogs he sells; (3) given a choice, buy dogs from working parentage; (4) put the dogs immediately where you want them to

work (i.e. don't raise a pup for several months in your home or yard and then later expect it to stay near the barn or in the pasture with your sheep); (5) start the dogs at an early age (8-12 weeks) with livestock and insure that the stock won't injure a young puppy or frighten it badly; (6) be patient--large working dogs may not mature until 2 or 3 years of age, so expect puppy problems (i.e. playing with sheep, etc.) for some time, but correct all undesirable behavior immediately; (7) give the dog some basic obedience training (come, sit, stay, no, etc.) - be able to reasonably control the dog; (8) even though a dog is of a guarding breed it may not necessarily perform the livestock guarding task satisfactorily (in such cases it may be desirable to work with another dog); (9) don't expect miracles, presumably the guarding is instinctive, but be prepared to teach the dog what you expect it to do and (10) some dogs tested here have successfully protected a small flock of sheep for several weeks from a sheep killing coyote.

Although there are many people who claim their dog provides 100% protection from predators and others who say that they wouldn't be in the sheep business were it not for their dog, dogs may not be everyone's solution to the predator problem. Careful consideration should be given prior to purchasing a dog to protect your livestock.

In addition to fencing and guarding dogs, research is continuing toward developing chemical reproductive inhibitors for controlling coyote populations. Research in this area is difficult and slow and is not expected to provide applicable results in the near future. The predator project also has the facilities to reliably test predator attractants, repellents, aversive agents or any other newly developed techniques that may arise for predator control.

These lambs graze contentedly and safely, protected from predators by an electric fence of special design.

VISITORS AND INFORMATION

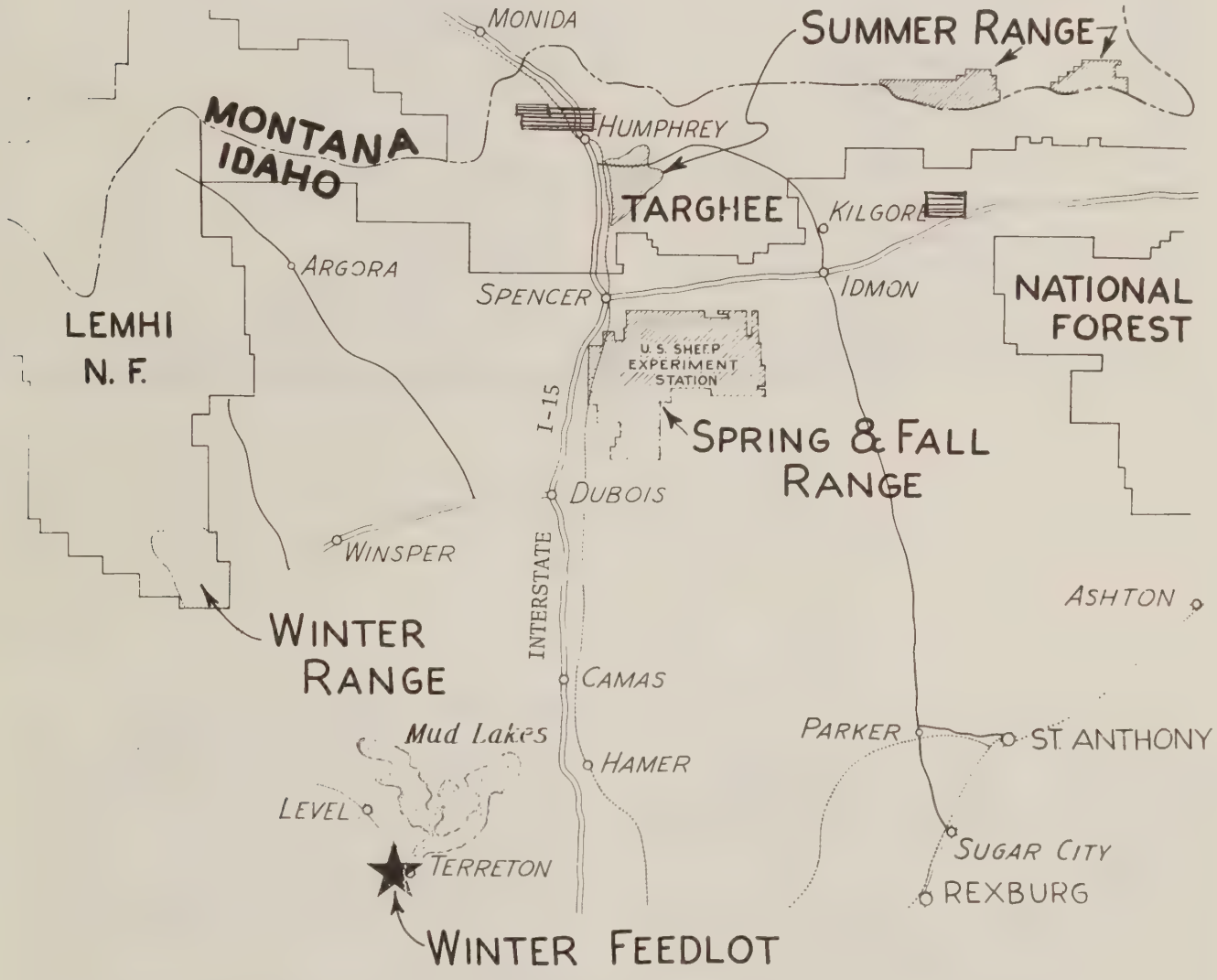
Visitors are welcome at the U.S. Sheep Experiment Station; however, tours should be arranged as far in advance as possible by contacting:

Research Leader, SEA-USDA
U.S. Sheep Experiment Station
Dubois, ID 83423

Business hours are from 8:00 a.m. to 5:00 p.m., Monday through Friday, except holidays.

Any questions regarding agricultural research at this facility may be directed to the above address. Questions about SEA research elsewhere in the Western Region, or anywhere throughout the Agency, may be directed by mail or phone to:

Area Director, SEA-USDA
Pacific Northwest Area
221 Ag. Science Phase II
Washington State University
Pullman, WA 99164



PROFESSIONAL AND TECHNICAL STAFF

U.S. SHEEP EXPERIMENT STATION

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S. Keith Ercanbrack, Ph.D.	Research Geneticist (Anml)
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Robert Murray, Ph.D.	Range Scientist
Quinn Jacobson, B.S.	Range Manager
Jeffrey S. Green, Ph.D.	Research Wildlife Biologist
Roger Woodruff, M.S.	Scientific Aid II, Wildlife Biologist

SCIENCE AND EDUCATION ADMINISTRATION

On January 24, 1978, four USDA agencies--Agricultural Research Service (ARS), Cooperative State Research Service (CSRS), Extension Service (ES), and the National Agricultural Library (NAL)--merged to become a new organization, the Science and Education Administration (SEA), U.S. Department of Agriculture.

SEA is the largest agency of its kind in the world, and the Agriculture Research (AR) staff is its major research arm. The primary mission of SEA-AR is to help in meeting the food and fiber needs of our nation and of the world.

SEA-AR works in close cooperation with State experiment stations, State departments of agriculture, other government agencies, public organizations, farmers, ranchers, and industry.

The Agency's research is conducted at more than 150 laboratories, field stations, and work sites in 46 States, the District of Columbia, Puerto Rico, the Virgin Islands, and nine foreign countries. In the United States, SEA-AR facilities are located in four locally administered geographic regions. Twelve Western States comprise the Western Region, which is headquartered at Oakland, Calif. Dubois is in the Pacific Northwest Area, one of four similar units subdividing the Western Region.

This organization structure is intended to insure both active research programs and maximum responsiveness to the needs and problems of the people.